REMARKS

The present application is a continuation of U.S. Patent Application Serial No. 09/370,104. Consideration of the application as preliminarily amended is respectfully requested. The applicant would like to, at this time, address the Rouet reference cited in an earlier related case.

Rouet discloses a method for creating or growing (col.3, lines 11-13) digital representations of hair. In an earlier office action filed in the parent case, col. 3, lines 1–13, and 38-47 are cited as anticipating the claimed invention of certain, but not all, the independent claims.

Applicable independent claims, for example claim 12 of the present application, include the phrase "in response to an external influence" to further clarify that which applicant regards as the invention. External influences may, for example, include wind and water.

In contrast, Rouet neither teaches nor discloses the claimed invention. Rouet discloses establishing a subset of individual control hairs that are subsequently used to generate or 'grow' a full head or body of hair automatically and for changing the hair characteristics such as shininess or curliness by drawing a texture map. (see Rouet col 3, lines 10–13; 38-50). Rouet does not teach or disclose modifying at least one area of hair to provide a visual effect to the area of hair *in response to an external influence* as required new claims 12-64.

For example, as set forth in the specification and certain claims, the claimed invention, in one embodiment, may be used to provide the effect of "clumping" due to the "hair" getting wet. There is simply no teaching in Rouet that the texture map would provide the modification in response to external influences as set forth in the amended claims.

The office action in the parent application also cited col 3 lines 1-4, 10-13, 30-36, 15-1 and col 4 lines 20-29, and 40-45 as supporting anticipation of the claims. Rouet discloses using control hairs and scattered data interpolation (see Rouet col 4 lines 15-29) as a technique for defining hair geometries and mathematical interpolation to derive hair directions for intervening points on a surface (see Rouet col 4 lines 40-45). However, Rouet neither teaches nor discloses averaging a number of hairs per square unit area

across sub-areas or determining a total number of hairs per unit area, and placing hairs in the sub-areas according to the total number of hairs per unit area.

The office action also cited col. 5, lines 20 – 23 and col. 3, lines 47 – 52 as supporting anticipation of the claims. As previously advanced, the generation of a visual effect on an area of hair due to an external influence is distinct from generating hair characteristics such as curliness and shininess from texture maps.

For the foregoing reasons, Applicants respectfully submit that all the pending claims are in condition for allowance.

Please charge any shortages and credit any overcharges to our Deposit Account No. 02-2666.

Respectfully submitted,

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Dated: April 16, 2002

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VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE SPECIFICATION

Please substitute the paragraph beginning on page 2, line 24, third full paragraph on page 2, with the following paragraph:

Some prior computer graphics techniques used for fur creation have achieved convincing looks of smooth fur; however, these techniques do not take into account that real fur often breaks up at certain areas of the body, such as around the neck. In addition, the prior methods do not account for hairs of wet fur that clump together resulting in a significantly different appearance compared to dry fur. Also, the process of simulating hair as it is getting increasingly wet when sprinkled on by water has not yet been addressed.

Please substitute the paragraph beginning on page 6, line 20, third full paragraph on page 6, with the following paragraph:

An alternate embodiment is illustrated in **Figure 1b**. Input is received by surface definition module 50 that defines a surface which, as will be explained below, defines surfaces and control hairs of the object to be rendered. Module 55 adjusts the control hairs to provide such functionality as combing and seamless hairs across surface boundaries. The [interpolation] interpolator module 60 interpolates across the surfaces using the control hairs. Hair clumping and breaking module 65 enhances the realistic visualization of the object by providing for clumping and breaking of hairs. Rendering module 70 renders the hairs and provides shading, black lighting and shadowing effects to the hairs, and module 75 displays the final output of the object with the hair surfaces

Please substitute the paragraph beginning on page 8, line 19, second full paragraph on page 8, with the following paragraph:

At step 400, seams are constructed between adjacent surfaces. Each seam identifies adjacent surfaces along a corresponding boundary (for example, an entire edge, T-junctions, or corners) of a surface patch. At step 405, for each surface patch, the boundaries are traversed, step 410. Each control hair is examined, step 412. At step 415,

if a boundary hair is found, at step 420, the neighboring patches, as identified by a corresponding seam, are checked to see if there is a corresponding hair on the neighboring patch. In one embodiment, a hair is corresponding if it is within a small predetermined distance from the boundary hair. The distance may be specified in parametric [u, v,] <u>*u, v,*</u> or absolute space. In one embodiment, the predetermined distance may be a relatively small distance such that the hairs visually appear co-located.

Please substitute the paragraph beginning on page 10, line 23, fourth full paragraph on page 10, with the following paragraph:

As noted above, animated [combining] <u>combing</u> may also be applied, step 345. Key framing, known in the art, is used to interpolate between combing changes specified at certain frames to proving smooth transitions between changes. Thus for example, bend curvature and fallout parameters may be specified to change at certain frames. The key framing process execution then transitions during the frames between the specified frame changes. This technique can be used to simulate a variety of conditions which affect the look of the hair, such as wind. Thus, the hairs can be animated by key framing the parameters and executing the combing calculations at each frame during playback.

Please substitute the paragraph beginning on page 11, line 11, second full paragraph on page 11, with the following paragraph:

The process includes an iterative algorithm that determines hair/surface intersections. For example, the process performs a line segment intersection check of successive control vertices of a curve (e.g., the NURBS curve) defining a control hair with the surface. If a control vertex [c] <u>*c*</u> goes below the surface, the hair is rotated back towards the surface normal from the previous non-intersecting vertex just enough for [c] <u>*c*</u> to clear the surface. The amount of rotation is large enough to cause the hair to rotate back up above the surface by a small amount specified by the application. Thus the vertices of the vector affected by the combing are rotated back towards the surface normal so that the vector is above the surface.

Please substitute the paragraph beginning on page 11, line 20, second full paragraph on page 11, with the following paragraph:

In an alternate embodiment, the combing may be animated by turning each control vertex of a control hair into a particle, and applying dynamic effects like gravity and external forces. Software, such as [Maya,] Maya™ available by Alias|Wavefront, a division of Silicon Graphics, Inc., Toronto Canada, may be used to perform this function.

Please substitute the paragraph beginning on page 11, line 29, ending on page 12, line 4, with the following paragraph:

One exemplary process for the placement of hairs on patches is illustrated by the flow chart of **Figure 5**. In this embodiment, final hairs are generated from control hairs in two set steps. First, the static hair features are calculated, e.g., the placement [(the u, v position)] (the *u*, *v* position) of the final hairs. This step may be performed once. The second set of steps may be performed for each frame in an animation and provide frame dependent hair features.

Please substitute the paragraph beginning on page 13, line 13, second full paragraph on page 13, with the following paragraph:

At step 530, the final hairs are placed. Since it is preferable not to place fractional hairs, either 3 or 4 hairs are placed depending on whether a uniformly generated random number in [0,1] is bigger or smaller than the fractional part (0.5999). The 3 or 4 control hairs are randomly placed in *u* [*ui*, *ui*+1] and randomly in *v* [*vi*, *vi*+1]. The process then proceeds back to step [515] 510 to the subpatch defined by the next four equally spaced points.

Please substitute the paragraph beginning on page 13, line 19, third full paragraph on page 13, with the following paragraph:

Each final hair contains a number of control vertices. The root position (first control vertex) of each control hair is specified in terms of a (u,v) value of the underlying surface. The remaining control vertices of each hair are defined in a known local coordinate system with origins specified at the hair root position, and axes in the direction

of the surface normal, [du, dv] *du, dv*. In one embodiment, each hair is oriented along the surface normal and the coordinates of the control vertices are generated by subdividing the length of each hair into n-1 equal parts, where n is the number of control vertices/hair. One example is illustrated in **Figure 7a**, where a hair 725 is defined on surface 730 with n=4. The root is vertex 720 and the remaining vertices are 705, 710 and 715.

Please substitute the paragraph beginning on page 13, line 25, ending on page 14, line 4, with the following paragraph:

Once the root position is calculated the enclosing control hairs (in one embodiment three) for each final hair are determined. In one embodiment, a 2-dimensional Delaunay triangulation [(know in the art and therefore not further discussed herein)] (known in the art and therefore not further discussed herein) is constructed of the [(u,v)] *(u, v)* positions of the control hairs for each surface patch. This triangulation was chosen because it creates "well-proportioned" triangles, by minimizing the circumcircle and maximizing the minimal angles of the triangles. Once the Delaunay triangulation is constructed, it is determined which triangle each final hair falls into. The indices of the three control hairs which form the particular triangle are assigned to the hair that falls into that triangle.

Please substitute the paragraph beginning on page 14, line 11, second full paragraph on page 14 with the following paragraph:

The above information of each final hair (i.e., the [(u, v)] *(u, v)* position, the 3 enclosing control hairs, and the weights of each control hair) may be generated only once for an object in animation. This information is referred to herein as the static information. In contrast, the calculation of the orientation of each final hair may be done at each frame of an animation. This orientation is determined from the orientation of the control hairs and their corresponding weights by an interpolation process as explained with reference to **Figures 7c and 7d**.

Please substitute the paragraph beginning on page 16, line 17, third full paragraph on page 16 with the following paragraph:

Referring to **Figure 8**, to determine clump membership of each final hair (i.e., what clump each hair belongs to, if any), the clump of the specified clump-size is converted into [u-radius and v-radius] *u*-radius and *v*-radius components in parametric surface space at each clump-center hair location, step 800. Each hair is evaluated at steps 805, 810 to determine whether it falls within the [u, v] *u, v* radius components of a corresponding clump-center hair. If the hair is not within the [u, v] *u, v* radius components, the hair is not a clump hair, step 815 and the process continues, step 830, with the next hair. If the hair is within the [u, v] *u, v* radius components, at step 820 the clump-center hair's index is referenced with the hair. In addition, a clump rate and clump percent is assigned, step 825.

Please substitute the paragraph beginning on page 16, line 25, ending on page 17, line 3, with the following paragraph:

A number of variations are contemplated. A clump-size noise parameter may be introduced to produce random variations in the size of the clumps. Feature (texture) maps for a clump-size can be created and specified by the user, one per surface patch, to provide local control of the radii used at steps 805, 810. In this embodiment, the global clump-size input parameter is multiplied for a particular clump (clump center hair) at [(u,v)] *u, v* on a surface patch with the corresponding normalized (s,t) value in the clump-size feature map for that surface. Also, a static clump-area feature map can be provided to limit clumping to specified areas on surface patches rather than the whole model.

Please substitute the paragraph beginning on page 17, line 25, ending on page 18, line 7, with the following paragraph:

In one embodiment, this process is performed at each frame. In one embodiment, the default value for number of control vertices (CVs) is 3 (4 minus the root vertex), and the index for the current control vertex [i] *i* ranges from 1-3. In one embodiment, the reorientation is determined as follows:

clumpHairCV[i] = clumpHairCV[i]+delta* (clumpCenterHairCV[i] -clumpHairCV[i])

delta = clumpPercent *(fract + clumpRate* (1 - fract)); where fract = i / numberOfCVs; clumpHairCV[i] represents a clump hair vertex; clumpCenterHairCV[i] represents a corresponding clump center hair vertex; i represents an index to a current control vertex; numberofCVs represents the number of control vertices of a clump hair; clumpPercent represents clump-percent; and clumpRate represents the clump-rate.

Please substitute the paragraph beginning on page 19, line 13, third full paragraph on page 19 with the following paragraph:

For each particle that hits a surface patch, including those particles generated in prior frames, a circular animated clumping area is created, step 1115, on the patch at that [(u,v)] *u, v* location, with clump-percent, clump-rate, and animated clumping area radius determined by a creation expression executed at the frame where the particle hits the surface so that when a particle hits the surface at that time (i.e., at the frame), the clump-percent may be set to zero and the radius may be defined to a specified value perhaps adjusted by a random noise value. Thus, the expression may be defined to provide the desired "wetness" effect.

Please substitute the paragraph beginning on page 19, line 21, fourth full paragraph on page 19 with the following paragraph:

The radius of the circular clumping area defined is converted into a corresponding [u-radius and v-radius] *u*-radius and *v*-radius similar to the clump size discussed above. Runtime expressions executed at each frame define clump-percent and clump-rate, thus determining how quickly and how much the fur "gets" wet. For example, one runtime expression may be: MIN(FrameNumber * 0.1, 1) such that as the frame number increases, the hair appears increasingly wet.

Please substitute the paragraph beginning on page 19, line 26, ending on page 20, line 3, with the following paragraph:

Each clump center hair of a clump (determined at step 1100) is then evaluated to determine if it falls within the animated clumping area, step 1120. To determine whether a clump falls within an animated clumping area, at each frame it is checked as to whether

the [(u,v)] (*u, v*) distance between the clump-center hair of the clump and the center of the animated clumping area is within the [(u,v)] (*u, v*) radius parameters of the animated clumping area. For clumps that are located in overlapping animated clumping areas, the values for clump-percent and clump-rate are added resulting in the generation of wetter fur.

Please substitute the paragraph beginning on page 20, line 26, ending on page 21, line 2, with the following paragraph:

In one embodiment, this potential problem is addressed. Whenever a new particle hits a surface and the [(u,v)] (*u, v*) radii exceed the boundaries of that surface; an additional [(u,v)] (*u, v*) center and [(u,v)] (*u, v*) radii is generated for the animated clumping areas affecting neighboring patches. Thus, for example, if the clumping area covers portions of two neighboring patches, a corresponding [(u.v)] (*u, v*) center and radii are generated for each neighboring patch to provide additional animated clumping areas for evaluation at steps 1120-1140.

Please substitute the paragraph beginning on page 21, line 24, ending on page 22, line 7, with the following paragraph:

One embodiment of the hair breaking technique is illustrated by **Figure 12a**. At step 1200 the fur tracks are defined. The fur tracks may be defined similar to clumps by defining a [(u,v)] (*u, v*) break radii. At step 1205 the break line hairs (hairs which lie on or are very close to the fur-track curve defined by the curve defined for the fur track) are computed. Using the break line hairs and break radii, at steps 1215, 1220, each hair is evaluated to determine whether the hair lies within the [(u,v)] (*u, v*) break radii on both sides of the break line hairs in case of symmetric breaking, or to one side specified by the break vector (the break vector side) in case of one- sided breaking. For each hair within the space specified by the radii, referred to herein as a break hair, the corresponding break line hair (hair on the fur track) is then determined as the one closest to it. The hairs are labeled as break line hairs, break hairs with indices to their corresponding break line hairs, or normal hairs that do not reside within the areas specified by the break.